XEROX

Xerox Network Systems Architecture

Introduction to Xerox Network Systems

INTRODUCTION TO XEROX NETWORK SYSTEMS

XEROX

XNSG 058504
April 1985

Text and graphics prepared on the Xerox 8010 Information System, and printed on a Xerox Electronic Printer using the Interpress electronic printing standard.

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Every company wants to improve their office operations, increase product quality, and enhance the productivity of their people. Office automation is the term being used by many to describe how companies are reaching these objectives by applying modern technology to the front office.

What do office people do? What do they produce? What does it cost? How good is it? And how long does it take to get results? These are some of the questions organizations should ask before they try to improve the way work is done. The output of office people is not easy to quantify. Yet we all know when reports are on time. We know when illustrations in a document help us understand difficult concepts. And we know how our own productivity is affected by the ease with which we can reach people who have the information we need.

Integrated Office Systems

Although we may not necessarily quantify the cost or value of the output produced in offices, we know we need to do a better job, to do it in less time, and to do it without increasing staff. How can we do this? The application of modern technology is perhaps the best way to increase the effectiveness of our people. Better management of information is the promise of office automation. While office automation is the common term, Xerox believes Integrated Office Systems better describes the kind of technology required to make people more effective in the things they do.

Effectiveness

How might you and those in your office be more effective? In many cases by having better communications. You need information from people or machines to do your job. You want the information you receive to be understandable, current, and available to everyone with a need to know. The faster you get it, the better job you do. Xerox has a particular interest in the management of information since some of the greatest productivity gains today are happening in this area

Communication

Better communication is a universal need. Offices are no longer confined to a single building or even several near-by buildings. Information must be readily available wherever it's needed in a geographically dispersed operation. So information is being stored and transmitted in electronic form to those who access it at their own workstations Information must also be readily

convertible from electronic form to hard copy form wherever and whenever it's needed.

System Solutions

Xerox has long recognized the need to apply modern technology to the needs of office people. Since the early 1970s, the Xerox Palo Alto Research Center has explored what "knowledge workers" do and how they communicate with each other. That research produced one of the first system solutions to improving the productivity of office people.

An Integrated Office System is more than just "business machines." It is a collection of machines, computer programs, and communication circuits provided by many different vendors that work well with each other and with people. It provides visible, easy-to-use devices used by office people and "invisible" devices operating in a support role. Most people are unaware of the invisible devices in good systems. Few know how a telephone system carries a voice to someone else or how the postal system is able to deliver items of diverse shape and "quality" anywhere in the world. We make our request (place a call, drop a letter in a box) and expect the "system" to do the right thing. Xerox customers have the same expectation when they use a Xerox system.

Simpler systems that are not integrated but satisfy specific short-range objectives are always possible, often at a lower price. The real test of a system's quality, however, is if it can be used over a long period as applications change and new technology is introduced. In the long run, systems that lack proper architectural support are seldom the most cost effective. They become obsolete in a short time and have to be replaced, often resulting in costly disruption for users. Xerox Network Systems architecture, with its long-range view, is for those users and suppliers who want to do it right the first time.

About this document

This document describes Xerox' approach to integrated office systems. It is a general discussion meant for those who want to know how office people can become more effective and productive by using the Xerox Network Systems. Both visible and invisible aspects of the Xerox system approach are described. The *Xerox Network Systems Architecture General Information Manual* is available for those who prefer a more technical description of the network architecture and its protocols.

2. XEROX NETWORK SYSTEMS OVERVIEW

An architecture is "a style and method of design and construction." This document describes the architecture of Xerox Network Systems (abbreviated XNS), the term describing the Xerox approach to interconnecting machines and communications to solve today's office problems.

Xerox Network Systems

Office machines have traditionally been designed to help one person do one job well (e.g., typing a document, calculating a bill, copying a letter). What a person or group hands to the next person or group in an organizational process is a "work product." It is the result of taking information or materials from other sources, adding value and creativity, then delivering new information and/or materials.

Today's organizations transfer information as physical documents on paper and will continue to do so for many years. Yet change is coming to the office. The work products of many people working in a number of different places must be integrated. Information can no longer be limited to one machine or one location. It must be part of a larger organizational resource. The objective of XNS is to provide exactly that kind of capability, primarily by linking people and machines together using a communication network.

XNS Architecture Principles

These are some of the principles of the XNS architecture:

- Distribute computing elements throughout an organization according to need without centralized computer control.
- Provide fast communication links for the users and providers of information.
- Implement national and international standards to allow easy interconnection of XNS systems with other networks and systems built on other architectures.

Ethernet

Ethernet is the local area communication network (or LAN) developed by Xerox, Digital Equipment Corporation, and the Intel Corporation. Its specifications determine the kind of transmission medium (coaxial cable), electrical signaling levels, and the way information must be transmitted over the

medium (transmission protocols). The Ethernet transmission protocols are independent of the medium. Products supporting these protocols may communicate with each other using fiber optics, twisted pairs of wires, or even radio broadcasting into the "ether." With passage of the IEEE 802.3 standard, Ethernet is now an internationally accepted communication standard. There are some minor differences between the version of Ethernet that Xerox has been using for several years and the one adopted recently by the IEEE 802 Committee and ISO. Now that this standard is approved, Xerox is migrating its products to the official 802.3 version of Ethernet, a process that started in 1985 with the incorporation of standard 802.3 transceivers and controllers into the product line.

Workstations and Servers

The Xerox professional workstation is one of Xerox' office automation products able to participate in a company-wide communication system. Word processing machines, personal computers, and electronic typewriters are other examples of the products providing document management functions through communication links. The IBM Personal Computer and Digital Equipment's VAX minicomputer are two of the many non-Xerox products that can also operate within XNS. Other types of XNS products include servers which provide services such as print, file and mail. (Appendix A contains a list of some current XNS products.)

Other Systems

An XNS local area network may be interconnected with other communication systems that do not implement XNS protocols (e.g., X.25 and SNA). A communication "gateway" converts the protocols to conform to the expectations of the receiving system. Neither perceives the other as "foreign."

The XNS architecture specifies the "rules of the road" for devices attached to local area communication networks and how local area networks interrelate with national and international wide-area communication networks. The network architecture represented by XNS is the underlying foundation for a diverse set of products. *Conformity to XNS principles insures that today's and tomorrow's products will work well together.*

XNS concepts and facilities

Fig. 2-1 shows four different products "attached" to a local area network. Because these products all "speak" the same communication language, they can communicate with each other. If there were no local area network (or if they did not "speak" the same language), each product would have to be completely self-supporting. That was the situation with the

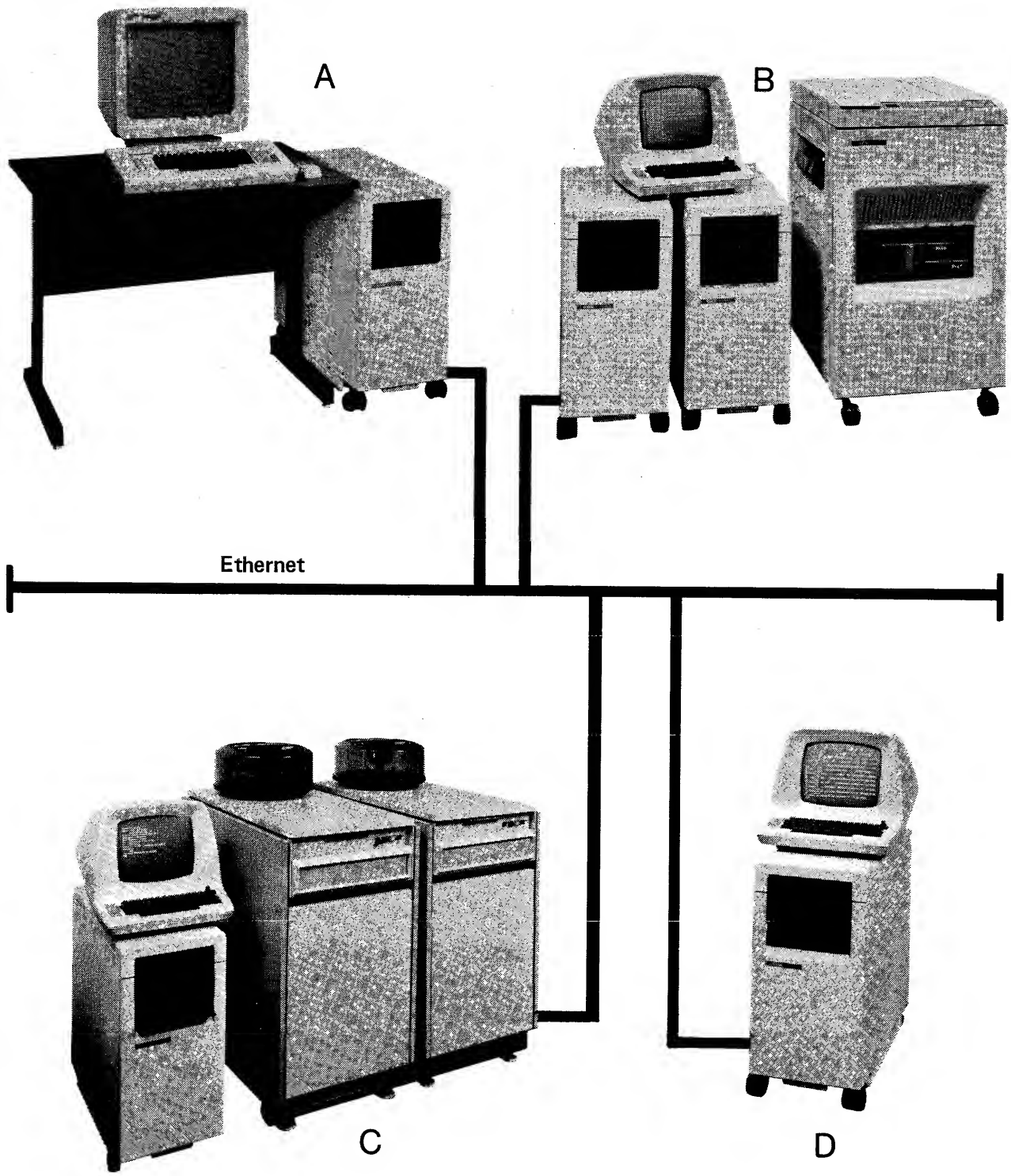

Figure 2-1 **Network with A) workstation, B) print server, C) file server, and D) communication server**

industry's first word processors: each had its own disk drives and character printer.

Internet

An XNS local area network linking different office machines serves an area limited only by the electrical characteristics of the underlying transmission medium (approximately a kilometer with a baseband coaxial Ethernet). Local area networks may be connected into a larger internet using special devices, called communication servers, and connected to public communication facilities, such as leased telephone lines and switched networks.

System Elements

The devices shown in Fig. 2-1 are called system elements. A system element is a computing resource supporting the XNS network protocols attached directly to a local area network. Any system element used directly by a person is called a workstation; otherwise it is a server. Many workstations share a few servers to print information on electronic printers, store it on large-capacity electronic files, or communicate it using external communication facilities.

Service and Clients

Software operating within a server is called a service. We speak of a print service operating within a server connected to an electronic printer. A service responds to requests received from other programs, called clients. A service may also become a client of another service, when it needs to use that service.

Services supporting filing, printing, mailing, and external communication are easy to visualize because the user is aware of these services and there is associated hardware required to provide the service.

XNS needs several other services that are not so visible. These services are essential to the smooth operation of an internet. They include:

Clearinghouse Service – An information resource with a directory of names and addresses of all users and services on the internet to help locate them.

Authentication Service – A validator of user credentials to insure a client is whom he claims to be for security purposes.

Time Service – A supplier of date and time for logging purposes.

Document Interchange Service – A converter of documents from one format to another to facilitate interchange.

Interactive Terminal Service – A mediator between the internet with its directly connected devices, and the externally connected terminals that do not support XNS communication protocols.

Multifunction Servers

XNS allows great flexibility in the configuring of services. For example, more than one service may coexist on the same system element. This is especially economical in small networks with light loads. If the demand for a service becomes so great as to slow overall server response to an unacceptable level, the overloaded service can easily be moved to its own individual server. As an internet grows larger, these services can be duplicated in several locations for reliability and to provide fast response to those who use the system. This distributed systems approach in the XNS architecture allows a user to change the system as his needs change, resulting in little or no obsolescence.

XNS standards and protocols

The Xerox view of an automated office is pictured as "information outlets" as ubiquitous as electrical power outlets (see Fig. 2-2). Of course anything plugged into such outlets must have the right shape and electrical voltage to be acceptable to the system "on the other side of the wall." But shape and voltage are far from sufficient. The devices plugged into the "information outlet" must "speak the same language" if communication is to occur.

Xerox introduces the Information Outlet.

If you're wondering how business will handle information in the '80s, the handwriting is clearly on the wall.

We call it the Information Outlet—a new way for you to custom design an information management system that will give you maximum flexibility with minimum expense.

Here's how it works.

The Information Outlet gives you access to a special Xerox Ethernet cable that can link a variety of office machines. Including information processors like the Xerox 860, various electronic printers and files, and, of course, computers.

The Xerox Ethernet network will enable people throughout your company to create, store, retrieve, print and send information to other people in other places—instantaneously.

This network wasn't designed to work exclusively with our equipment. Other companies' products can be connected as well.

As your needs change, so can your network. You'll simply plug in new machines as you need them—or as technology develops better ones.

So, through the Xerox Information Outlet, you'll get to the future the way the future itself will get here.

One step at a time.

XEROX

Figure 2-2 A Xerox "Information Outlet" advertisement

Communication Standards

A company could support the Ethernet local area network specifications, but not support the XNS communication standards. Such a company's products would be able to communicate among themselves, but not with the broad array of products attached to the same network that do follow the XNS standards. It is therefore in a vendor's best interest to support XNS standards so their products may be interconnected with those already installed on an existing XNS system.

Most of the XNS communication standards specify the protocol (or format) required to make or respond to requests. Protocols are layered for modularity and have versions for extensibility.

Layered Structure

Consider layering. If you want to change a payroll deduction, you have to provide information on a particular form and answer all questions. But answers are not enough to get action. You must encapsulate your answers into, let us say, an addressed intra-company envelope. The mail room may encapsulate that into another envelope so it can be sent through the U. S. mail. The post office encapsulates many envelopes into bags and bags into trucks. Eventually a decapsulating process takes place and your form arrives at the payroll "service." Following the appropriate protocol at each step of this transmittal process is absolutely critical for delivery success.

Encapsulation

Encapsulating information into "envelopes" along the transmission route is like protocol layering. The initiating application follows the form established for requesting or supplying information. This is encapsulated by the protocol able to process interactions and is delivered to another layer. The next protocol sequences the data into packets and presents it for transport. The transport protocol encapsulates packets into a "container" for the communication medium. Just as most of us know nothing about the steps required to get a payroll form to the right office, applications know nothing about intervening transmission protocols. Applications are only concerned with getting requests into the right format. The transmission "layers" are invisible.

Version Numbers

Because there must be a way to introduce new features requiring potentially new formats, the XNS protocols have version numbers. Each transaction carries the number of the protocol version being used. Devices that accept service requests state the range of versions they can accept. When this range is fairly wide, new features can be introduced gradually into an integrated office system.

3. XNS COMMUNICATIONS

The rapid communication of information is critical in today's offices. XNS supports extremely high-speed information communication within a single building using a local area network, and communication between local area networks using the slower, wide-area communication facilities provided by common carriers.

Layered architectures and the OSI Reference Model

In 1981 the International Standards Organization adopted the *Open Systems Interconnection Reference Model*. This layered model has been accepted throughout the industry as a convenient way to view communications architectures. The functions associated with each layer must be provided in every network architecture to make it possible to interconnect different communication facilities and standards at different layers. For example, with the OSI Reference Model, applications can use different network architectures (such as XNS Communication or SNA) with a variety of lower level communication facilities (such as leased lines or XNS local area networks).

XNS and the ISO standards

The OSI Reference Model has seven layers, beginning with layer 1 on the bottom where the most primitive communication functions occur, and moving up to layer 7 on the top where applications do "work" for a user. The Model describes in detail the structure of network and communications functions, but does not do so for the Application layer which often has its own sublayers to perform different functions. The XNS architecture model conforms to the OSI Reference Model, and groups some of its functions in fewer layers for convenience. The XNS architecture also describes the Applications structure in greater detail.

In addition to the reference model, ISO has also been developing and adopting standards for each of the communications and network layers. Some of these standards, such as those for the physical and data link layers for local area networks (IEEE 802.3), are identical or nearly identical to the XNS standards. Other ISO standards are in formative stages. As these international standards become accepted and widely used, they will be supported within the XNS architecture. The close correspondence between the XNS and OSI Reference Model and ISO standards makes this a relatively easy task.

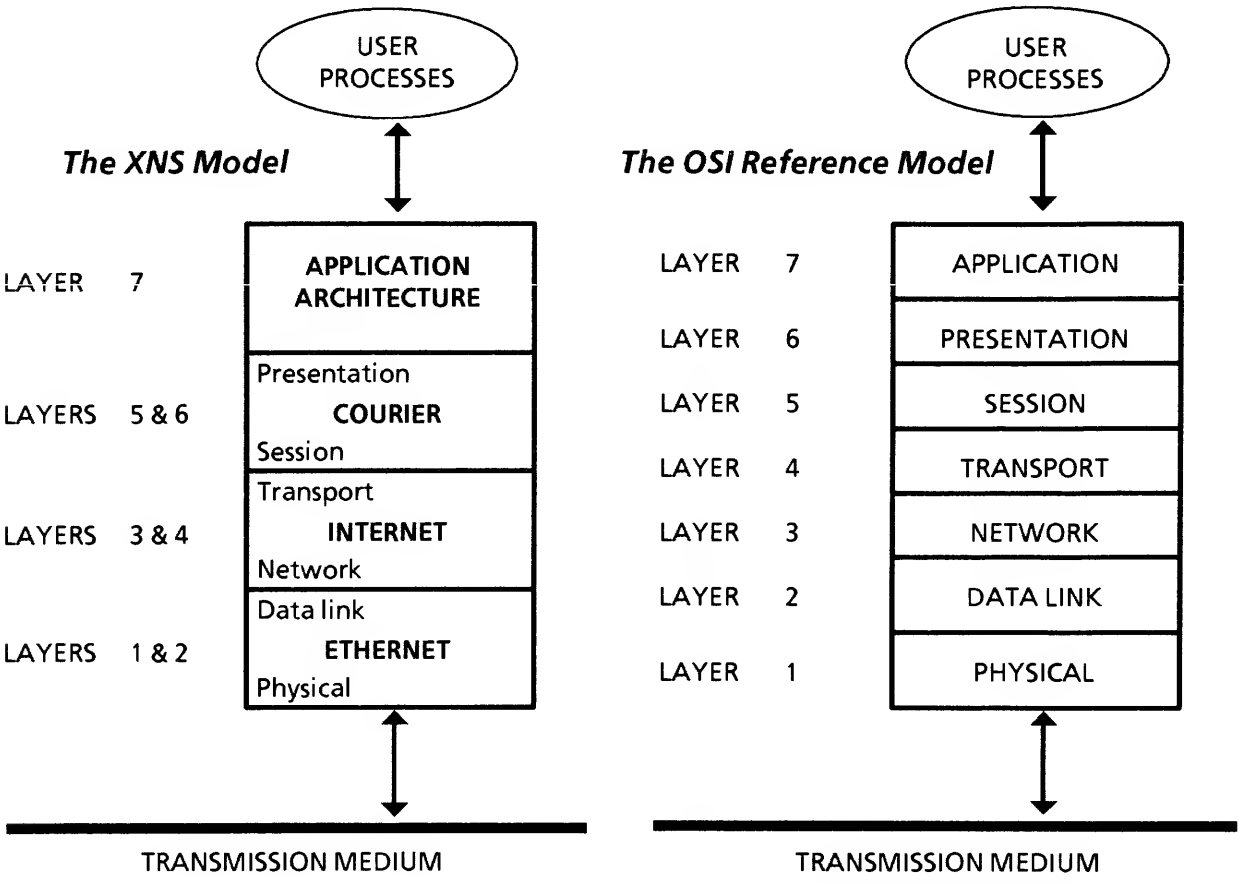

Figure 3-1 **The layered approach to communications**

The seven layers in the OSI Reference Model, shown in Fig. 3-1, correspond to these functions:

Layer 1: Physical — Bit stream manipulations, dialing (for switched networks), modem control, and other fundamental tasks related to data transmission take place at this layer.

Layer 2: Data Link — The rate of data flow through a network is controlled at this layer. Transmission errors are detected (and may be corrected).

XNS implements the Physical and Data Link layers as embodied in the Ethernet specification. The Ethernet specification clearly separates the physical and data link layers to allow different physical media to be used with the Ethernet data link protocol. Traditional data communication interfaces such as EIA RS-232-C, RS-449, and CCITT V.4, V.35, X.21, and X.25 are also supported within XNS.

Layer 3: Network — This layer makes the network addressing, routing, and switching decisions. It also provides recovery from some transmission errors.

Layer 4: Transport

At this layer messages are organized into the correct form for transmission on the selected transmission service. Some network management tasks are also performed.

XNS implements the Network and Transport layers in a series of protocols called Internet (a word referring to the set of all connected local area networks). The Internet Transport Protocols specification separates the different transport and networking functions.

Layer 5: Session

The establishment of a communicating relationship between a requester and requestee occurs at this layer. Buffering and queuing of messages might also be done if necessary.

Layer 6: Presentation

The data forms used and understood by applications are converted into data forms used in lower layers (and vice versa). The conversion may be as simple as changing one binary code into another, or as complex as altering the way the complete information is represented.

XNS implements the Session and Presentation layers in Courier, a protocol used to make remote procedure calls (requests).

Layer 7: Application

This is where specific applications are performed, such as filing, printing, and mailing, and where the user's communication requests originate.

XNS implements the Application layer in an application architecture which embodies a series of interrelated applications that build upon a common support environment including a character code standard, application formats, and network services. It is this richness of applications built upon a solid foundation that makes the XNS architecture so useful and versatile.

Protocols

Much of what has been written about network communication in XNS documents describes protocols. A protocol is a set of agreements between two nodes on a network that are required to accomplish some task. There are many protocols in XNS. Some will be described in later sections of this document.

Of course users are most interested in obtaining information and results from applications. The local area network, the Internet, and other communication mechanisms used to provide that information are largely hidden, much as it is with the telephone network itself.

Local area network

A local area network is the cabling within an office which carries local communication traffic (usually at very high speeds). Ethernet is a particular local area network and is the

foundation of XNS. Although the first Ethernets used coaxial cables and baseband signaling, Ethernet versions now can operate over other forms such as broadband channels and even fiber optic cables and twisted pair wires. All these diverse physical media work with the same Ethernet data link protocol. It is Xerox' intention to incorporate other physical media into its product line as they are adopted by the standards organizations and are accepted by the users. It is important that there be agreement among vendors and users about the physical media that will be installed for local area networks so that equipment from different vendors can operate together without requiring redundant wiring installations. Xerox has been actively supporting such standardization.

Ethernet Components

Fig. 3-2 shows the hardware components required for a baseband Ethernet using coaxial cable. The cable itself is passive; no central resource (power, electronics, computer) is required to allow individual system elements to communicate with each other. System elements attach to the cable via a tap, control electronics (transceiver) located near the cable, an extension drop-cable, and further electronics (controller) located in the system element.

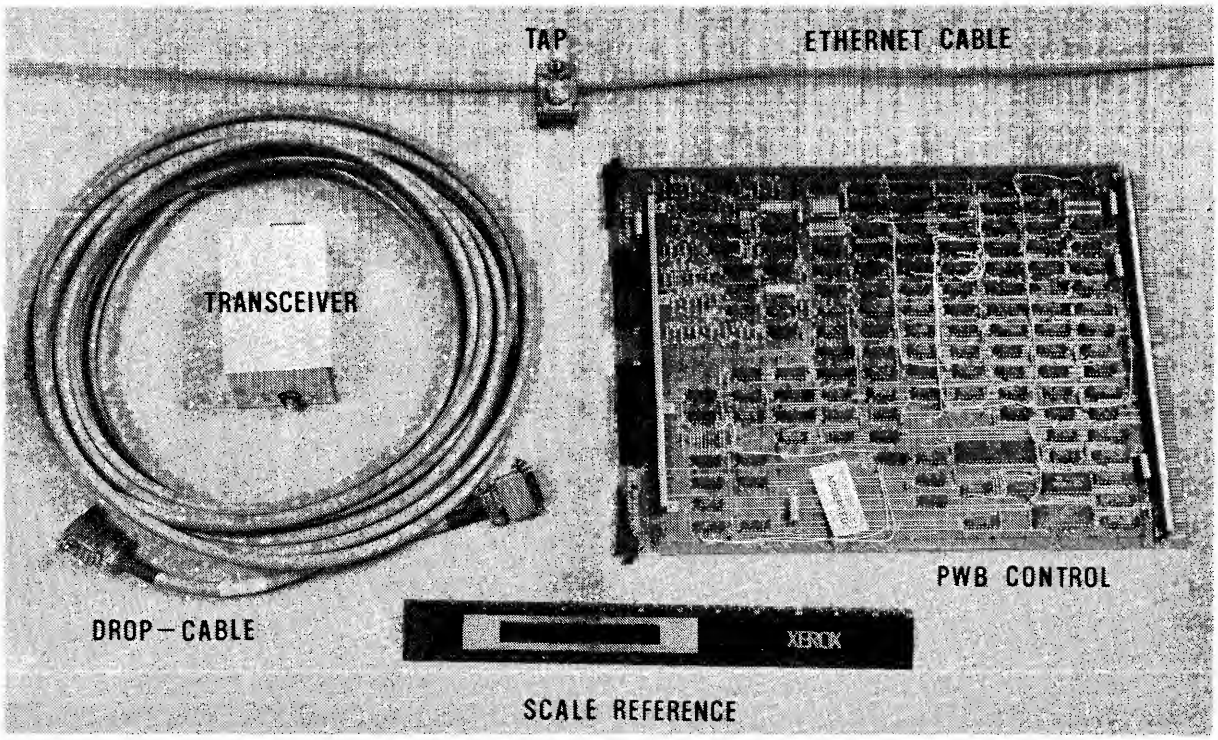

Figure 3-2 **Ethernet cable, tap, transceiver, drop-cable, and PWB control**

Ethernet Transmission

An Ethernet transmits digitally encoded packets of information between system elements at the rate of 10,000,000 bits per second. A transmission speed this fast is important because fast transmission rates mean less transit time for each piece of information. This creates the illusion that remote information is "close" to the user. Since each communication use is very brief, there is a high probability the Ethernet is available for transmissions when a system element needs to communicate.

Since individual use of an Ethernet produces only light loads, many system elements can share a single Ethernet with no noticeable degradation. This means an Ethernet can support highly responsive information handling even if the information is not on the local system element.

Ethernet accommodates the exchange of information by system elements built by different manufacturers. Any system element conforming to Ethernet rules may tap the cable. The conventions for gaining access to the Ethernet provide fairness among all system elements. Control electronics within each system element "listen" and "speak" on the Ethernet much like members of a group listen and speak in polite conversation.

CSMA/CD Communication

Before transmitting, a system element listens for other transmissions. This is possible because the Ethernet is a broadcast medium; all information sent on the Ethernet can be heard at each system element. If a system element hears another transmission, it waits until the Ethernet is quiet before beginning its own transmission. If two system elements transmit at once (because they both detected a quiet Ethernet), each stops as soon as it realizes it cannot be heard properly. This condition is called a collision. After a collision a system element waits a random time, then retransmits its information. Long transmissions are broken into short segments (called packets). Each system element must listen before transmitting a packet, thereby reducing the chance of one system element monopolizing the communication channel. The technical term for communicating this way on a local area network is CSMA/CD: Carrier sense, multiple access, /with/ collision detection.

A local area network like Ethernet normally serves one building. The cable is typically located in the ceiling above halls, with drop cables running into individual offices. Large buildings may require more than one local area network because a single cable (segment) is restricted in length. Repeaters may be used between segments to extend the length of a local area network or to branch out within a building. Repeater use is limited because the Ethernet must be short enough for each system element to hear other traffic.

The internet

Most organizations have offices in different locations that must be interconnected to maximize productivity and effectiveness. Each may have its own local area network, but these networks must be linked together to form a much larger network. The collection of linked local area networks is called an internet.

The linking of two local area networks may be done by high-speed digital microwave or laser communication links if a line-of-sight path between the two sites exists. Or communication circuits provided by common carriers or public data networks can be used to link local area networks anywhere in the world. Leased circuits should be used when the communication traffic between two locations is heavy. Dial-up, on-demand circuits may also be used when appropriate.

Leaving the local area network

Internetwork Routing Service

When a local area network is linked to other networks in a larger internet, a system element called an Internetwork Routing Service must be attached to every local area network that is a member of the internet. The Internetwork Routing Service (IRS) resides in a communication server. It supports the switching of packets from one medium (such as a local area network) to another (perhaps a leased private communication circuit) and forwards packets to their final destination (see Fig. 3-3). An IRS is even able to dial-up another IRS when permanent communication links are not available.

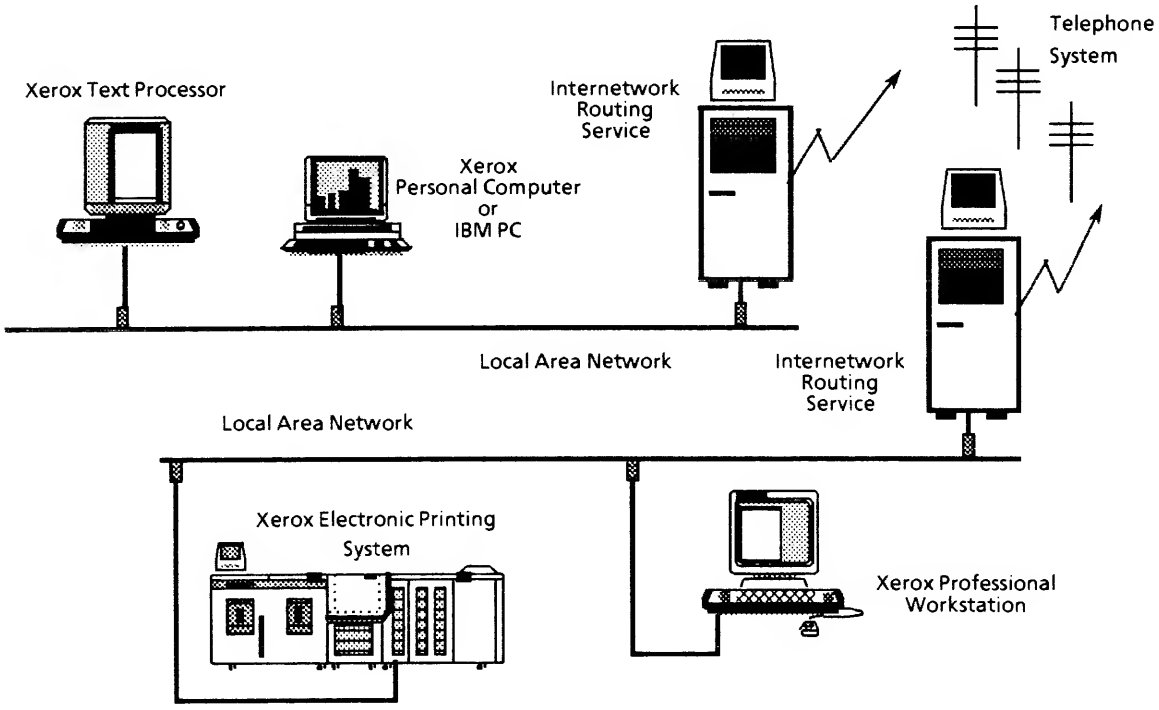

Figure 3-3 Two local area networks interconnected by a communication line

To accomplish the forwarding function, each IRS holds a complete map of the internet. This map contains the address of each remote network, how far away it is, and the next IRS along the path to get there. When an IRS receives a packet to be forwarded to a remote network, it uses its map to find the address of the network and sends the packet along its way

using the shortest path to that network. IRSs on an internet exchange their maps on a regular basis. After an IRS is activated, it gradually learns of the complete internet map from neighboring IRSs by means of this exchange. Likewise, changes to the internet gradually propagate from one IRS to another until all IRS maps reflect the change.

IRSs provide the initial path information to other system elements, answering questions like "How do I get to network 5-432?" If the system element determines that IRS A has a shorter path to a particular network than IRS B, IRS A will be chosen as the first IRS in the journey to the final destination.

Packets destined for a remote network may leave a local area network which supports transmission speeds measured in millions of bits per second and enter a public data communication network with speeds measured in thousands of bits per second. This results in a backup of packets in the IRS. Even though the IRS provides space for this backup, if packets continued to arrive at high speed, the IRS would soon be flooded with packets to send. Fortunately, transmission protocols between the end system elements on the remote networks avoid such backup by sending small clusters of packets.

When transmission occurs over the slower media connecting the local area networks, a user notices that it takes far longer to retrieve or send information. The more frequently a remote network must be accessed, the higher the throughput of the interconnecting communication media should be. A single building is typically self-sufficient; it is common for it to have its own high-capacity magnetic disk files and electronic printers. Communication with resources on other local area networks will likely occur relatively infrequently. Activity with a remote network might only be required to retrieve something stored on a file or to print a document for someone at a remote site.

X.25 Communication Protocol

Many different kinds of data networks can be used by IRSs to transmit information. Data networks are characterized by the protocol used to transport packets through them. One such protocol is the public packet-switching network standard developed by CCITT called X.25. This international standard supports very large public data networks which are themselves interconnected to provide international virtual circuits.

Clusternet Communication

The XNS architecture and the IRS also allow users of remote workstations to access each other and the internet via dialed telephone lines. One or more RS-232-C (CCITT V.24) connections can be designated as a clusternet, and assigned a network number, which allows them to communicate with other networks.

Communicating on the internet

Packet Encapsulation

Transmission of information on any network follows specific protocols appropriate to that network. As with a personal letter, an information unit generated by an application program is first "wrapped" in an envelope displaying the address of both source and destination. This is called encapsulation. Encapsulation occurs each time a packet is sent. An arriving information unit is "unwrapped" or decapsulated when it is received. This process occurs repeatedly as a packet travels across an internet.

The size of a communication packet, the location of source and destination addresses, a checksum, and other control information are all specified in the XNS protocols. A packet must be further encapsulated by another "envelope" when it is given to a particular transport service. The Ethernet protocol has one specification. The X.25 public packet switching network standard has another. But regardless which network carries a packet, the surrounding "envelope" is always removed before the packet is delivered to the receiving program.

XNS Addressing Conventions

Every local area network has a unique 32-bit network number. Any system element directly attached to a network has its own unique 48-bit identifying number. Xerox provides a central registry for blocks of network and system element numbers to eliminate conflict among organizations that support XNS protocols. All organizations must assign unique network and system element numbers to their own networks and system elements from their assigned block of numbers.

Courier: remote procedure calling

A computer program within a standalone product must be completely self-contained. It may only access particular programs stored on its own directly connected storage devices or ask a user to insert a needed program disk. An internet changes this. Instead of centralizing processing into a single computing resource, computational elements may be decentralized into a potentially world-wide internet. Requests for information may be made to entities no matter where they are located.

Functions provided by a decentralized system element are available through procedures that are called by a requesting program. A remote procedure might, for example, be invoked to return information stored on a single system element, such as the current date and time. Storing information on a single system element insures that it is consistent across many system elements. A remote procedure might also serve to provide access to a valuable shared resource, such as an electronic printer. Sometimes a remote procedure performs a function

that could be performed locally, but is appropriately off-loaded to a separate system element to gain parallel processing. In all cases a remote procedure is as easy to invoke as a local procedure.

Remote Procedures

Many services on the network may be considered as remote programs consisting of many remote procedures. Every invocation of a remote procedure requires an identifying program number, procedure number, and usually associated parameters. A mail service remote program may, for example, be considered as a collection of remote procedures including one to deliver a message to a user, another to accept a message for a recipient, and another to list messages waiting. Every procedure returns a positive response (the expected results) or an error whenever it is called.

Courier Protocol

Courier is the remote procedure call protocol that governs information interchange between a requester of a service (called a client) and the procedures which provide the service (called a service). When an active system element such as a workstation makes its first remote procedure call to some remote service, the Courier protocol creates a virtual circuit for all future procedure calls that are part of the same transaction. The link between requestor and responder stays active for the duration of a complete transaction.

Network management

Network management has traditionally been associated with managing telephone systems and modems. A network manager might be responsible for determining who gets what equipment and with what access rights, for publishing an internal telephone directory, diagnosing problems, and for reconfiguring the system to meet user needs. The internet, including all its associated system elements, must be similarly managed. However, the problem of managing an internet is more a problem of managing a distributed system. Managing the communication components is a subset of this.

Service Monitoring

Network management in a distributed system involves monitoring the services and communication components of the internet. While most networks support monitoring only from a central network control center, entities in XNS can be monitored from any system element in an internet. Access control to network management tools prevent unauthorized use. The monitoring of services includes performance and load statistics, and unusual events. Monitoring communication components include statistics that assist in problem determination, plus network planning and configuration. The Server Monitor Service watches over servers on the internet, assesses their

availability and reports problems to a system administrator through mail messages.

System Installation and Reconfiguration

Services must be installed on or removed from servers in flexible ways. No internet remains unchanged for long. It is the "backbone" of the automated office and must continually adapt to the changing needs of the organization it serves. The XNS distributed system approach makes it easy to implement change. System administrators may be distributed throughout an organization to provide local system installation and reconfiguration or the system administrator function may be performed from a remote network or a remote workstation. Network integrity is maintained by the strong emphasis on security in the XNS architecture. This gives great flexibility in network management and control.

4. XNS WORKSTATIONS AND TERMINALS

A workstation is used by an operator to do work. A workstation has local resources and provides direct access to network resources (called services). Services appear to a workstation as though they were local because of the speed of XNS communications facilities.

A terminal usually has limited local resources and does not support XNS protocols. Terminals may access selected network services by communicating with a service which acts as an intermediary between the terminal and the internet.

Directly connected workstations

Xerox Professional Workstations

A workstation directly connected to a local area network must support the protocols employed on that network. The Xerox professional workstation shown in Fig. 4-1 is an example of a workstation that may be directly connected to an Ethernet. It has a keyboard, a pointing device called a mouse, a higher

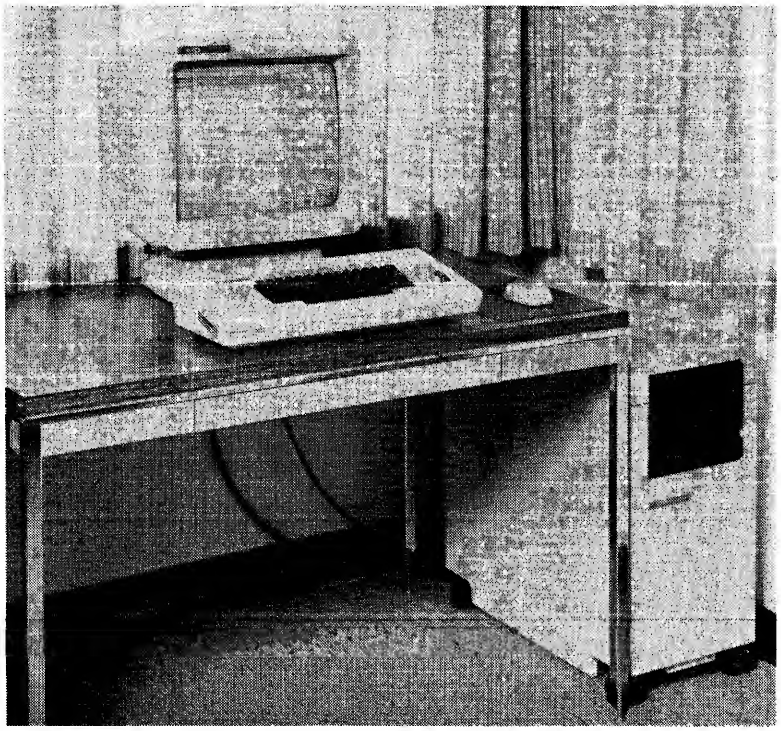

Figure 4-1 A Xerox professional workstation

resolution, large display screen, a floppy disk, and a rigid disk for local program and data storage.

The user interface on Xerox professional workstations provides an easy way for anyone to create, file, mail, or print information. Documents may contain text in many different type styles and sizes, plus charts and drawings integrated with the text. Documents always appear exactly as they will be printed. Most system options appear on "pop-up" menus and can be activated by merely pointing at an option and clicking a button. Available network resources are shown as pictorial images on the screen (called icons). The icons in Fig. 4-2 show an "in" and "out" basket for mail, different printers, a [remote] file drawer, several documents, and folders containing any number of documents.

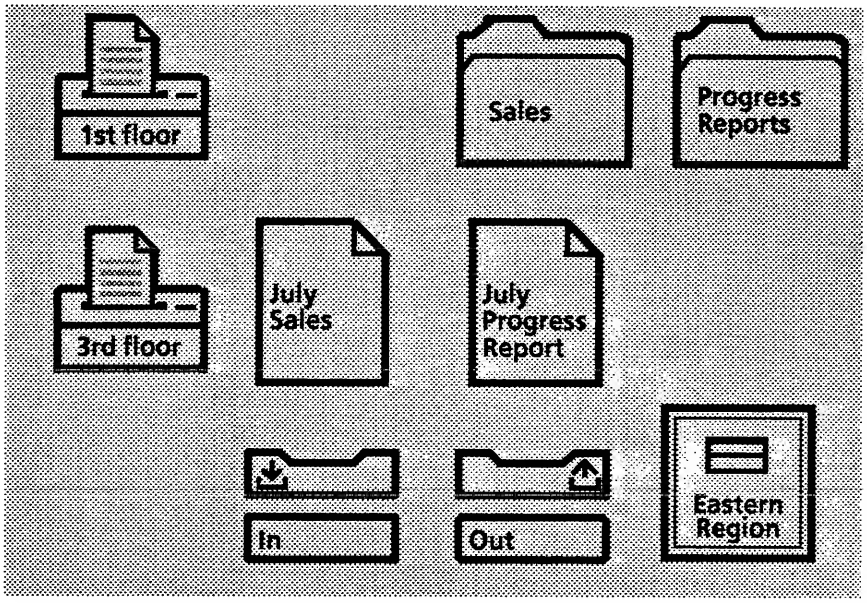

Figure 4-2 **Portion of a user's desktop**

A user interface like this makes services on the network readily accessible. User actions are intuitive, always consistent, and extremely friendly.

Xerox Text Processors

The Xerox text processors, such as the 860, may also be connected directly to the network. When it has an Ethernet controller board and the control software, an operator may optionally select network communications. A normal menu will appear allowing access to the network services of print, file, and mail. An experienced text processing operator needs almost no additional training to use network services.

IBM Personal Computer

An IBM Personal Computer or a fully compatible equivalent may also be connected directly to the network. An Ethernet control board is inserted into one of the empty slots on the PC and connected to an Ethernet drop cable and transceiver. Xerox-provided software operating within the PC displays a

user interface for direct access to print, file, and mail services. Any Wordstar document, or file formatted for an Epson printer, or an Interpress master may be printed using many different printer features (e.g., multiple fonts, portrait and landscape orientation, two-sided printing, different paper sizes). Files in any format may be stored and retrieved on a file service. Electronic mail may be received from and sent to users at a variety of workstations directly and indirectly connected to the network.

Xerox Personal Computers

Xerox personal computers such as the 820-II and the 16/8 can also be directly connected to the network to access all of the XNS services. This connection can be made via a shared interface unit (SIU) which connects one or more Xerox personal computers to the network.

Indirectly connected terminals

Directly connected devices such as the Xerox professional workstation or the IBM PC require an Ethernet control board plus special software to connect a user to the services available on the network. Indirectly connected devices such as terminals, electronic typewriters, or personal computers can also have access to these same services using only a modem, a telephone, and the device's normal communication software. Even a remote, non-networked Star workstation may connect to a network using TTY or VT100 emulation capabilities.

Indirectly connected terminals may access print, file, and mail services using the Interactive Terminal Service (ITS). ITS is like a "black box" with telephone "ports" to the outside world on one side and a direct Ethernet connection on the other. A user connects to a telephone port and transmits characters in asynchronous ASCII format. ITS provides a user interface, internal character buffer space, and access to the local area network. Since ITS supports many telephone ports simultaneously, it is really a time-shared computer. Individual users appear to have the exclusive use of ITS. Name and password is required first to identify a user. Then available options are shown in a menu, "help" information is available to those who want it, and all the capabilities of print, file, and mail network services are available for user invocation.

Clients and services

Any computer program that initiates a request on the network is called a client. Such a request is typically triggered by

someone at a workstation or terminal. The computer program receiving a request from a client is called a service.

Services are computer programs residing in system elements directly attached to a local area network. These system elements with their peripheral devices are called servers. We may, for example, speak of a file server (meaning the hardware) or a file service (meaning the software). A server may have more than one service co-resident on it (e.g., a mail service and a file service may share the same server). Services are normally passive. They don't generally initiate action on their own behalf, but respond to requests from clients. In responding to clients, a service itself may become a client of another service (e.g., a file service asks the clearinghouse for information on a client filing a document).

Application Protocols

Requests must be made according to the Applications layer protocols appropriate for each service offering. The protocols govern the type and format of legitimate requests and the responses that may occur. A client uses the appropriate applications layer protocol to make a request. The request is sent "down" through the other layers, over the physical communication internet, "up" through the receiving protocol layers, and eventually decoded by a service.

If workstations and servers do not support the XNS protocols, they will not be able to "speak" with devices that expect these protocols. Such incompatible devices may be intermixed on a single local area network if the same data-link and physical transmission protocols are used. But all network services which depend on particular higher layer protocols cannot be used unless the right "protocols" are used when making requests.

Networks improve the productivity of people by providing the benefit of resources and services to those who do not have them available on their workstation. Such resources include electronic printers to convert electronic information into "marks on paper," high-capacity electronic or magnetic disk files so information may be shared among people in the same building, or thousands of miles apart, electronic mail for near-instant communication and wide distribution, and many other less visible services needed to make a network system operate reliably and effectively.

Application support environment

The less visible support services for the more visible applications at the top layer of the architecture must be available on the network because they are used by nearly all network programs. These constitute the application support environment base for XNS application architecture.

Clearinghouse

When you want to call someone but don't have the number, you contact an Information Operator. If you provide a name, and perhaps additional characteristics such as city or street name, you will receive the number if it is on file. The Clearinghouse Service is very similar to an Information Operator.

Names and Addresses

People expect to identify the printers, files, communication gateways, and electronic mailboxes by name. If the computer program within a workstation needs the address of some named resource (equivalent to its phone number), the Clearinghouse will supply it. In this case the Clearinghouse responds like someone looking up a number in a telephone directory's white pages.

The Clearinghouse is a very versatile service which supports the use of aliases and default names within the same domain for user convenience. In addition, the service associates the qualified name with not only an address, but a set of properties which describe the object associated with the name.

The Clearinghouse also accepts requests for the names and [network] addresses of all resources of a particular type, perhaps all electronic printers in a particular location. In this case the Clearinghouse responds like someone looking for something in the yellow pages.

Database Replication

A small network would probably have only a single Clearinghouse. As an internet grows, additional Clearinghouses are added so the operation of the internet does not depend upon the availability of a single resource. Those who add or subtract resources on the network or register new people for electronic mail need only update the data base in their local Clearinghouse. The Clearinghouse Service is implemented as a distributed system which means that the various Clearinghouse services in an internet actively cooperate to form a unified system by automatically updating each other's databases.

A major benefit of this distributed approach is database replication which allows duplication of the Clearinghouse database on multiple servers, providing enhanced reliability, availability, and efficiency.

Fig. 5-1 pictures a Clearinghouse Service in a separate system element, though on a small network it would co-exist with other services in a single system server element. Requests to the Clearinghouse Service require the use of the Clearinghouse protocol.

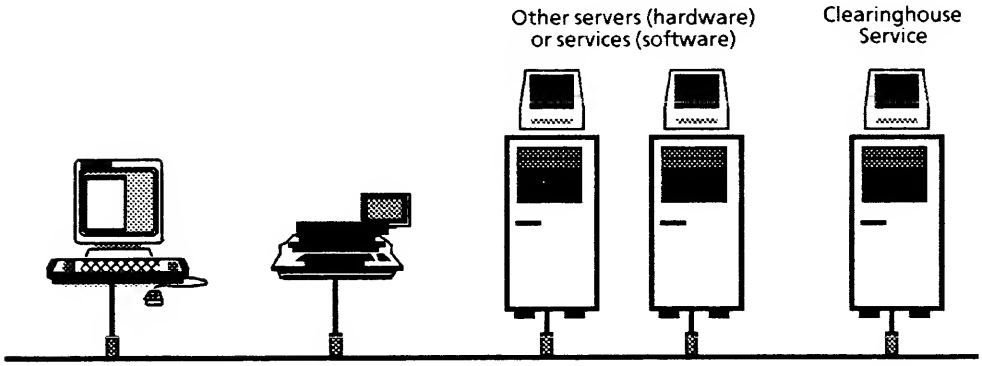

Figure 5-1 **The Clearinghouse Service provides addresses for names**

Authentication

Security is important on every network, even one within a single room. The services on such a network still need to validate the identity of those making requests. A time service might provide the time to anyone who asks. But a file service cannot be so generous. Files may be private information which must be restricted to those with the proper authorization.

The software within a workstation needs to validate that a name and password entered at a keyboard are correct and known to the system. Requests sent to services on the internet must have a reasonable guarantee of being handled by the addressed resource and not some imposter program masquerading as a service.

Credentials and Encryption

The Authentication Service provides information to be sure people and resources are what they claim to be. It keeps a list of the passwords and encryption keys for all system resources. When a client wishes to contact a service, it first obtains "credentials" from the Authentication Service. The client then uses these credentials to encrypt a request which only the correct service understands. Various other safeguards are also provided to be sure all network resources communicate safely and securely with each other.

The Authentication Service usually coexists with the Clearinghouse Service on the same physical hardware, and accepts requests according to the rules of the Authentication protocol.

It should be noted that trusted people must be given privileged capabilities to manage certain sensitive administrative procedures associated with the Authentication Service. The XNS architecture allows for this selective access by authorized users.

Time

What time is it? Ask ten people and you may get ten different answers. Having the correct time is so important to a network that a Time Service is provided to supply it. The time supplied is an absolute number of seconds in Greenwich, England, from a particular starting time. The Time protocol provides a means to adjust this time to the local value where it is used.

Global View of Time

XNS takes a global view of time because XNS internets already exist which stretch from Japan, through North America, and into Europe. Times associated with specific actions or log entries are consistent no matter where in the internet the time-stamping occurs.

The Time Service usually coexists with the Clearinghouse Service on the same physical hardware.

Character codes and fonts

A global view of information interchange on a world-wide internet requires a rethinking of the encoding of individual characters. In English-speaking countries the 7-bit ASCII code is widely used in workstations and terminals. 8-bit codes are also used in many computers, and these provide twice as many

characters. But this is still not adequate. Special accents, Greek, mathematical, and printing-oriented characters quickly exceed the 256-character capacity of an 8-bit code. When the needs of Japanese and Chinese are taken into consideration, hope for using a restricted code space vanishes.

Multilingual Capability

Xerox has developed a new way to encode characters. The first "page" of 256 characters conforms to the ASCII and ISO codes for the common North American characters. This is an 8-bit code. But when it's necessary to encode Greek, Cyrillic, Japanese, or other special characters, an escape code allows use of other code "pages" and expands the code to 16-bits. This provides compactness as well as sufficient capacity for the needs of the foreseeable future.

Although the Xerox character code is not a service *per se*, it is an important building block for all XNS applications. Full multilingual document generation and printing is available on selected Xerox products.

Font Architecture

A character code defines a character's identity, but not its precise visual appearance, which includes its typeface, size, orientation, posture, and other attributes. Fonts supply this missing information. The character code and font together define how a document "looks." Xerox has developed the necessary font architecture to assure that documents throughout the network system can be displayed and printed with typeset quality and a high-degree of consistency. A document looks the same whether displayed on a workstation or printed on any number of output devices.

Print Service

For years word processing equipment produced documents in hard copy form using inexpensive character impact printers. But now that images and sophisticated graphics are becoming a part of written material, non-impact electronic laser printers are becoming essential. An electronic laser printer "paints" images on paper using a laser much like a television set uses an electron beam to paint pictures on a screen.

A Print Service accepts documents from client programs and prints them on a directly connected electronic printer or other output device. It responds to requests for its status and the properties of its printer. Such properties include whether it can print on both sides of a page, staple pages together, handle graphics, and the like. The client initiating a print request receives a unique identifier for each document to permit tracking its status. Printer status includes information on what the Print Service is doing at that moment and the status of

previously accepted documents. Documents sent to an XNS Print Service must be in a standard format called Interpress.

Interpress

Interpress is the standard Xerox format for documents in final form to be rendered into "marks on paper" by an electronic printer. Interpress is not a format used by an editor. It standardizes the interface between the creator of a document and a printer of that document. Interpress is a Xerox standard that is independent of a workstation's or printer's specific characteristics (e.g., resolution [dots per inch], paper size, the presence or absence of particular fonts, and the like). It has been widely implemented on both Xerox and non-Xerox workstations and printers, and it can be used to interface virtually any type of document creation device to virtually any type of document printing device.

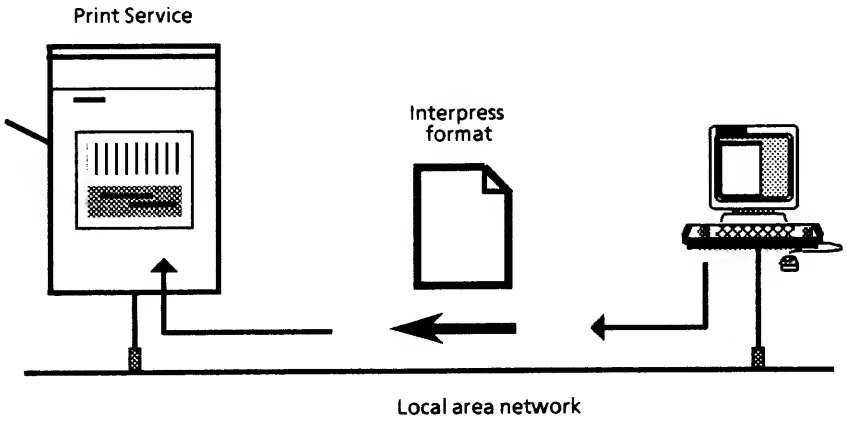

Figure 5-2 **Transmitting a document in Interpress format to a print server**

Page Description Language

Interpress was designed to take full advantage of the capabilities of today's laser printing technology for high-resolution text and graphics. It is a language for describing and manipulating the pages to be printed. It has a variety of commands for describing text, graphics and pictures, plus commands for creating various shapes, rotating them and scaling them. It includes instructions for assembling and finishing a document.

Performance Oriented Standard

Interpress enables high-performance printing for simple as well as complex pages, and works economically with both high-speed and low-speed printers. For example, the Xerox 9700 Electronic Printing System decomposes a complete Interpress description of a complex page and prints it in less than a second. Interpress is also well suited for commercial printing applications. It includes utility programs to merge different parts of a document such as text and illustrations into a single document, or to create signatures used in the printing industry.

Any document in the Interpress format may be sent to any Xerox electronic printer or facsimile device on the internet, using the Printing protocol. A new printer which accepts documents in Interpress format and supports the Printing protocol may be attached to the internet and used immediately by document creation devices. Interpress may also be used in conjunction with other network architectures and may be used with other media, such as magnetic tape.

The XNS Print Service supports the capabilities of electronic printers and facsimile devices. The open-ended flexibility of the Printing protocol and of Interpress makes it possible to also support phototypesetters, plotters, and other output devices.

File Service

Word processing equipment and most personal computers store documents in electronic form on flexible diskettes holding several hundred thousand characters. Since diskettes can be removed from a machine and stored off-line, there is almost no limit to the number of characters that can be recorded this way. But storing documents on diskettes is inconvenient when they must be shared with others, especially those in remote locations. And off-line storage can be troublesome if no one can locate a particular diskette.

Documents stored locally at a workstation may also be stored in a File Service. High-capacity disk files are able to store documents to make them available to users on the internet.

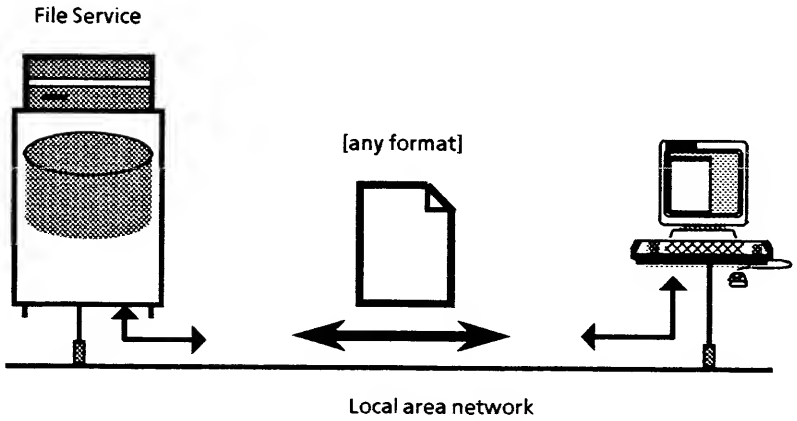

Figure 5-3 Transmitting documents between a workstation and a file server

File and Document Management

A File Service accepts requests from client programs to store, retrieve, and delete files, and to change descriptive information associated with previously stored files. The File Service maintains a hierarchical directory to all files starting with the files for a particular user (called a "file drawer"), and continu-

ing down through subfiles ("file folders"), and sub-subfiles (documents, spreadsheets, and the like).

Access Control

The owner of a file drawer is not restricted in the use of his file drawer. He may also grant unlimited access rights to anyone, or specify limited access (e.g., retrieval only) to specific individuals or groups. The File Service does not honor requests from clients unless authorized by the access list associated with a file drawer.

The File Service does not control the content of what it stores. If a document in ASCII format is stored and then later retrieved by a non-ASCII device, the document will essentially be unintelligible. A document conversion service must be used to convert information encoded in one format into the format used by a dissimilar device.

Document Interchange Service

If a company uses a single type of document creation device and a single version of document creation software, all documents are interchangeable among all devices. But such a situation almost never exists. Older devices coexist with newer ones. One group of users may prefer the characteristics of one particular word processing software package on their system while another group prefers a different package on identical machines. How, then, may the documents created by a group like this be shared among everyone?

The Xerox Professional Workstations do have software to convert to/from the format of the older Xerox 860 Information Processor. They can also convert a document in their format to/from the DIF format used by many vendors of word processing equipment. Although this helps alleviate some document interchange problems, it is not a complete solution.

The XNS architecture includes a Document Interchange Service that can convert a document to and from standard formats. The number of document formats supported by this service is currently limited, but growing.

Interscript

Interscript is the Xerox document interchange standard for documents in revisable form. It is not meant to be the format for direct internal use by a workstation editor. A document in Interscript format, called a script, must first be internalized (converted) by an editor or a document interchange service into a particular local format. An edited document meant to be

interchanged with a different editor must be externalized into a script (see Fig. 5-4).

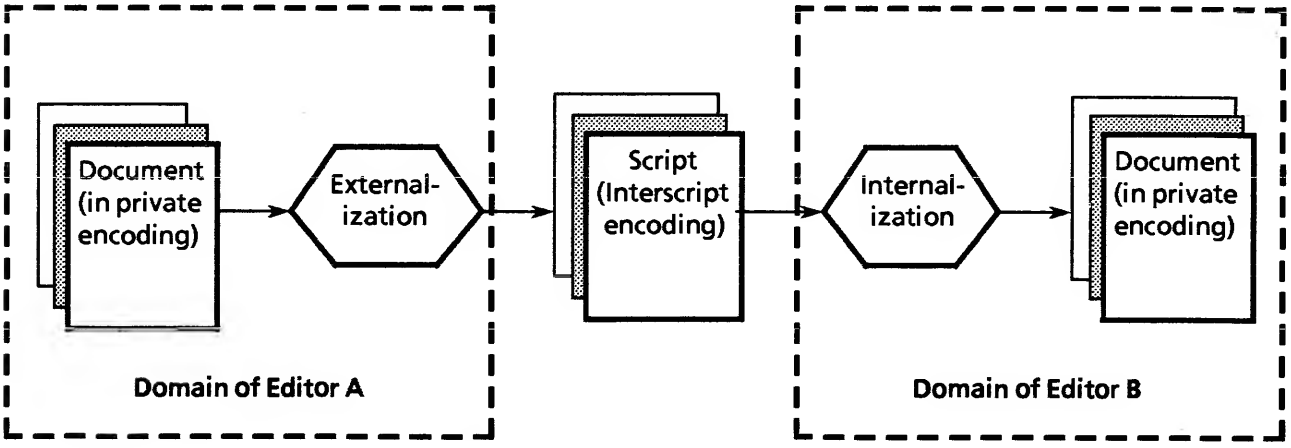

Figure 5-4 **Document interchange using the Interscript standard**

It would be perhaps faster to convert a document from one format into another without using Interscript or any other intermediate form. However, the number of converters to support all common editors would be so great, that many would never be written, causing incompatibilities in the system. When a standard intermediate form such as Interscript is used, only one pair of converters is needed for each format.

Document Representation Language

Interscript is a computer language for representing content, logical structure, and layout structure of a document. It is capable of representing complex documents in their editable form, including text, graphics, and pictures, and can be extended to include virtually any kind of digital information such as digitized audio.

No Information Loss Goal

An editor is expected to preserve without loss any part it does not recognize (e.g., graphics) in a script. Such unrecognized parts should be re-encoded back into a script after those parts of a document an editor does understand have been revised by a user. This goal of preserving everything may not happen immediately. Conversions from scripts to the format of almost any existing editor may initially be limited to converting those information constructs recognized by that editor.

Mail Service

Electronic mail is document communication between people that is transported electronically, not physically. Information appears on display screens and may never actually appear on paper. A Mail Service is able to accept a message from one of its clients and redirect it almost instantaneously to the appropriate Mail Services associated with the recipients.

Messages may also be dispatched to distribution lists whose members are added and deleted by the list's owners.

Electronic mail is an effective way to communicate when a transaction does not require person-to-person interaction. Sender and receiver alike may "process" their mail as their schedules permit. Electronic mail is even more valuable when communication must occur among individuals who are on different continents. The time differences between Europe, the United States, and Japan severely restricts interactive voice communication during normal business hours.

The common way to use the Mail Service is to compose a mail note on a workstation, provide the names of the recipients (including distribution lists) and submit it to a Mail Service for delivery. Unlike most electronic mail systems, XNS Mail Service supports not only messages, but full attachments which can include typeset text, graphics, record files, or any other electronic information. This unique general-purpose capability on a system-wide basis is one of the major strengths of the XNS Mail Service. XNS also permits user names to be full legal names (instead of some computer-selected initials such as DJones or DMJ). It also allows use of aliases, and assists clients to find valid names when they have only partial information.

The XNS Mail Service uses the Clearinghouse to convert any distribution list into the corresponding user names. If all the recipients are known to the system, the message is accepted. It is copied into the electronic mailboxes of those recipients serviced by the accepting Mail Service and, if necessary, also transmitted to one or more remote Mail Services serving the other recipients. The electronic message remains in a mailbox until retrieved by the recipient. The Mail Service will send only one copy of a message to any recipient even if that recipient is on two or more distribution lists getting the message.

A Mail Service may coexist in the same hardware as a File Service or other service entity. Of course, two or more services in the same system element must be separated into individual system elements when they become overloaded and unable to deliver the speed of response required by a system's users.

Gateway Services

An XNS internet can be linked to resources and networks built on other system architectures through the use of gateways. A Gateway Service is a system element that bridges the differences between the XNS "world" and some other system "world." It translates data formats, protocols, character codes,

and the like so each system perceives the other as an extension of itself.

External Communication Service

Access to Mainframe Computers

XNS workstations use the External Communication Service (ECS) to access non-XNS mainframe computers. This service works in concert with terminal emulation capabilities in Xerox workstations which simulate the appropriate terminal protocol (3270, VT100, or TTY). The External Communication Service operates within a communications server which has the physical and logical connections to communication circuits leading to the outside "world." A workstation on the internet to which this server is connected may send information to any computer that supports 3270 (SNA or Bisynchronous) or Asynchronous communication protocols. The ECS can simultaneously initiate and maintain sessions between several workstations on the internet and remote host computers connected to individual external communication circuits. A Communication Interface Unit is used to provide additional RS-232-C ports as shown in Fig. 5-5.

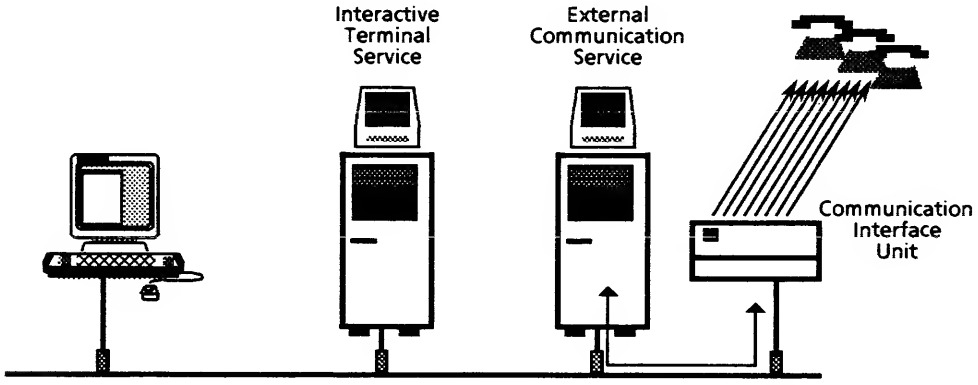

Figure 5-5 The External Communication Service and the Interactive Terminal Service communicate with non-networked devices

Other Network Architectures

The External Communication Service communicates with external computers using the appropriate native protocol for each computer, and with XNS workstations using XNS protocols. It thus enables the interchange of information originating in different parts of an organization even though those parts use different communication systems and network architectures.

Interactive Terminal Service

Workstations and terminals not directly connected to the internet may access XNS print, file, and mail services through the Interactive Terminal Service (ITS). ITS supports communication with TTY-like terminals and personal computers using standard communication protocols. Nearly all computers with

standard RS-232-C communication ports are able to operate that way. Xerox Memorywriters, personal computers, and word processing systems can also access XNS resources using ITS (with the appropriate communication options).

User Interface to XNS Resources

ITS provides a user interface to the remote devices to give "authorized" users access to XNS resources. Users at remote devices interact with this user interface to store and retrieve documents on a file service, print documents on electronic printers, or send and receive electronic mail. During a communication session a user has the illusion of being directly coupled to the internet. That's because ITS "speaks" to the internet using XNS protocols once it determines what a user really wants to do.

Fig. 5-5 shows the Interactive Terminal Service as a separate server. In practice, it usually coexists in a single server with the External Communication Service.

Scanning and reprographics

Text and generated graphics (line drawings, bar charts, etc.) are only two of the forms of information used in documents. A third important form is the scanned image which is generated when an existing hard-copy image is converted into a digital representation by electronic scanning. Scanned images can be combined with text and graphics to form composite electronic documents of richer information content.

Graphic Input

XNS provides scanning services that allow the creation, printing, storage, and mailing of scanned images and composite documents. The Xerox 150 Graphic Input Station is an example of a scanner that allows a user to convert line drawings, photographs, signatures, logos and the like into electronic form for inclusion in documents that can be printed on the Xerox 9700/8700 Electronic Printing System. This saves users time and expense compared to alternative processes used in conventional publishing. Scanned images may be electronically filed for later retrieval when printing occurs.

Intelligent Scanning

The Kurzweil Intelligent Scanning System is another example of a scanner that enhances user productivity. This device scans a hard-copy document and converts the text characters into a standard internal form as though they typed by a user. This facility is useful for data and document entry, especially when large amounts of information must be transcribed for computer use. A document converted into internally stored text may be easily processed by computers and occupies far less storage than if it were stored as a scanned image.

Electronic Reprographics

Another application of scanning is in reprographics. Hard-copy is normally reproduced by copiers, duplicators, and printing presses, using optical imaging systems. The availability of high-speed and high-resolution electronic scanners and printers would offer a user the option of electronic reprographics. Hard-copy may be scanned electronically before multiple copies are printed. Such a system offers a user a number of important capabilities and productivity benefits such as signature printing, customized publishing, quality improvements, and the ability to combine hardcopy information with electronic information in imaginative ways. Such types of systems bridge the gap between conventional printing and electronic printing.

Raster Encoding Standard

Scanned images require a large amount of electronic storage space. Any page in this document could require more than a million bytes of information. Compression techniques are needed to reduce this. In XNS the Raster Encoding Standard (RES) is used to encode and compress a digitized image for subsequent use.

RES is a general purpose encoding and image format that permits an image to be used by itself or as parts of other documents to be handled by Interpress or Interscript. RES uses the Interpress encoding rules which greatly simplifies printing. This standard is independent of specific device characteristics and provides great flexibility in the use of compression techniques and can be used for a variety of image types.

6. APPLICATIONS OF XEROX NETWORK SYSTEMS

The Xerox Network System architecture governs the way equipment is linked together through local and remote communications. Yet people don't want equipment; they want solutions to their problems. What solutions does Xerox provide through the XNS approach to systems? Here are a few:

XNS Solutions

Document Creation – XNS facilitates joint authorship and collaboration by permitting documents to be created on one device, edited elsewhere, and printed anywhere in geographically dispersed locations.

Document Publication – XNS supports in-house document publication by providing equipment able to create and print complex documents containing text, pictures, charts, and drawings, and print them in quantity as finished document sets.

Demand Printing – Information may be printed anywhere at any time from stored electronic masters.

Electronic Mail – Near instantaneous document communication among all a company's knowledge workers can occur using electronic mail. Information can be widely distributed at the touch of a button.

Information Sharing – All kinds of stored information may be accessed by people wherever they are, subject to XNS security provisions.

Engineering Design – Specialized engineering workstations and plotters support the production of logic diagrams, logic simulation, and automatic drafting.

Artificial Intelligence – Artificial Intelligence systems are available to augment the intellect of professional problem solvers.

Integrated Office Systems – XNS can "mix and match" old and new Xerox and non-Xerox equipment in an integrated, harmonious whole.

A few themes are evident from a list like this: tie a national or internationally dispersed organization together into a single, productive enterprise; get what you need, when and where you need it; create and distribute information more flexibly

than ever before; and provide these capabilities without disrupting the way people operate.

Xerox is committed to providing the best hardware, software, and systems to make the generation and utilization of information in today's businesses better than it has ever been. The solutions to today's information management problems include specific products linked with other products in imaginative ways. And there's more. Xerox knows advanced office automation systems must also have features people may not think about:

XNS Features

Reliability: By distributing and replicating key services so a system's operation is not compromised by the failure of a single machine.

Security: By protecting a system against unauthorized activities.

Flexibility: By accepting and supporting equipment made by others, and by allowing for distributed control.

Expandability: By making it easy to grow or change a network to meet user needs.

Ease of use: By providing the best ways for people to harness the power of the system.

These are some of the many reasons so many organizations are working with Xerox to solve their information management problems. They realize that Xerox Network Systems are right for today's problems and flexible enough to meet tomorrow's needs.

A. XEROX XNS PRODUCTS

These are some of the many Xerox Network Systems products. Detailed information on these and other XNS products and on permissible configurations is available from your Xerox representative.

XNS Print Servers

Xerox 5700, 8700, and 9700 Electronic Printing Systems
Xerox 8040 Series Print Servers

XNS Special Output Servers

Xerox Facsimile Print Service, Versatec 790, 791
(for Versatec printer/plotters)

XNS Workstation Products

Xerox 820-II Personal Computer (via SIU)
Xerox 860 Information Processing System
Xerox 16/8 Professional Computer (via SIU)
Xerox Star and Multilingual Star Workstations
Versatec Expert Series Engineering Workstations
Xerox 1108 Artificial Intelligence Workstation
Xerox 610-640 Communication Memorywriters
Xerox Development Environment (XDE)
Fuji Xerox 8080 JStar-II Series Workstation

XNS Graphic Input Products

Xerox 150 Graphic Input Station
Kurzweil 4000 Intelligent Scanning System
(via 860 Gateway)

XNS Services

Xerox 8030 Series File Servers
Xerox 8070 Series Communication Servers
Xerox 873 Communications Interface Unit
Xerox 8000 NS Interactive Terminal Service
Xerox 8000 NS External Communication Service
Xerox 8000 NS Internet Routing Service
Xerox 8000 NS Clearinghouse Service
Xerox 8000 NS Authentication Service
Xerox 8000 NS Time Service
Xerox 8000 NS Mail Service
Xerox 8000 NS External Mail Gateway Service
Xerox 8000 NS Clusternet Communication Service
Xerox 8000 NS X.25 Communication Service
Xerox 8000 NS 850/860 Gateway Service

XNS Services (continued)	Xerox 8000 NS Remote Batch Service
	Xerox Shared Interface Unit (SIU)
	Xerox Secure Information Devices
XNS Hardware/Software for non-Xerox Products	IBM PC on the Net (PC, PC/XT, PC/AT, Portable PC, and PC compatibles)
	DEC VAX on the Net
Communications Protocols and Interfaces	Asynchronous Communication Protocol
	3270 SNA/SDLC Communication Protocol
	3270 BSC
	ANSI 3.64/VT 100 Terminal Emulation
	2770/2780/3780 BSC Batch from File Service

XEROX

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Printed in U.S.A. 4/85 (15M) 610P50767